Bacteriological Assessment of Stethoscopes Used by Medical Students in Nigeria: Implications for Nosocomial Infection Control

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Abstract

Our study assessed bacteria on swabs taken from the surface of the diaphragm of stethoscopes used by medical students in Nigeria. We found bacterial contamination on 80.1% of the stethoscopes. *Staphylococcus aureus* and *Pseudomonas aeruginosa* were major isolates. Bacterial colonization was highest among stethoscopes cleaned with only water and those never cleaned with any agent or never cleaned at all. The difference was statistically significant ($\chi^2 = 31.9$, $p < .05$). Stethoscopes from students who cleaned them after use on each patient and from those who practised handwashing after contact with each patient had significantly lower bacterial contamination ($\chi^2 = 26.9$; $p < .05$ and $\chi^2=31.9$, $p < .05$, respectively). Isolates of *Staphylococcus aureus* showed the highest susceptibility to antibiotics, while the most effective antibiotics were ciprofloxacin and erythromycin. Integration of stethoscope care in the training curriculum of medical schools will enhance the control nosocomial infections.

Introduction

It is estimated that at any one time more than 1.4 million people worldwide are suffering from infections acquired in hospitals (nosocomial infections) (Tikhomirov 1987; Vincent 2003). Healthcare-associated infections occur worldwide and affect both developed and developing countries. Infections are considered nosocomial when they become clinically evident during hospitalization (at least 72 hours after admission) (Orrett et al. 1998). In developed countries, between 5% and 10% of patients acquire one or more infections, and 15–40% of patients admitted to critical care are thought to be affected (Lazzari et al. 2004; Klevens et al. 2007). In resource-poor settings such as most developing countries including Nigeria, rates of infection can exceed 20% (Pittet 2005; WHO 2008), but available data are scanty and more research is urgently needed to assess the burden of nosocomial infections in developing and transitional countries. Hospital-acquired infections exact a tremendous toll, resulting in increased morbidity and mortality, and increased healthcare costs (Haley et al. 1985).

Infection transmission in the hospital environment remains a significant hazard for hospitalized patients, and

healthcare workers are a potential source of these infections, with many pathogens transmitted by hand and by stethoscopes (PatentStorm 2004). This is the rationale for the time-honoured advice for all to wash their hands before and after seeing each patient. However, transmission of infection though contaminated medical devices is also a possibility. Outbreaks of nosocomial infections have already been linked to devices like electronic thermometers, blood pressure cuffs, stethoscopes and latex gloves (PatentStorm 2004).

The stethoscope is commonly described as an instrument used by physicians and other health professionals to hear the sounds made by the heart, lungs and various other body organs. Stethoscopes used in hospitals by medical doctors, medical students and other health practitioners for assessing patient health have been reported as a potential vector for transmitting infections in the hospital environment in various parts of the world (Cohen et al. 1997; Zuliani-Maluf et al. 2002).

There are increasing reports of the tremendous risk of transmitting antibiotic-resistant bacteria from one patient to another from stethoscopes. Because most hospital-acquired infections are primarily nosocomial and not autoinfections (Hoogkamp-Korstanje et al. 1982), their acquisition in the hospital environment adds to morbidity, mortality, and economic costs (Parmar et al. 2004). Despite the stethoscope's universal use by medical professionals, its proper care is not emphasized enough in the medical curriculum (Osorio et al. 2000). In Nigeria, stethoscope care is hardly covered in undergraduate medical training, and even when students are taught about nosocomial infections, little or no emphasis is placed on the potential of the stethoscope to transmit infections in the hospital environment. This accounts for some of the differences in the knowledge, attitudes and practices among medical students in the use of the stethoscope and its role in nosocomiasis in Nigeria.

The objectives of this study therefore were (1) to assess stethoscope handling and maintenance practices among medical students, (2) to determine the bacterial agents that can contaminate stethoscopes used by medical students, (3) to determine the antibiotic sensitivity of bacterial isolates from stethoscopes used by medical students, and (4) to highlight the relationship between medical students' stethoscope handling/cleaning practices and stethoscope contamination and its implications for nosocomial infection control in Nigeria.

Materials and Methods

Study Population/Sampling Methods

The study population consisted of medical students of Ebonyi State University Abakaliki, in southeastern Nigeria. Study participants were all in their clinical levels, that is, fourth- (400 level), fifth- (500 level) and sixth-year (600 level) medical students. We selected students at these levels because a greater part of their training consists of contact with patients in the hospital. The study took place from July 2007 to March 2008 at the Ebonyi State University Teaching Hospital (EBSUTH) Abakaliki, where the students are undergoing their clinical training. The study was approved by the Infectious Diseases Research Division of Department of Medical Microbiology of Faculty of Clinical Medicine, Ebonyi State University Abakaliki. Sampling was done in the lecture halls, just before the commencement of a lecture. Students were not informed in advance about the research in order to avoid the Hawthorne effect (where subjects improve the specific aspect of their behaviour simply because they know it is being studied). A brief talk was given on the purpose and importance of the study, and the students were encouraged to participate. The rate of compliance was very high: all who had their stethoscopes with them willingly participated. They were assured that all responses would be treated with utmost confidentiality and that the sample collection and analysis had been designed in such a way that the information could not be linked to a specific participant.

After obtaining informed consent from each participant, we administered an anonymous study questionnaire to gather information on demography, handwashing, stethoscope usage, and handling and maintenance practices. The questionnaire was given only to students who had their stethoscopes with them. A sterile swab stick moistened in a physiological saline was swabbed all over the surface of the diaphragm of each stethoscope and transferred for analysis to the Medical Microbiology Laboratory of Ebonyi State University Abakaliki. All laboratory analyses were done within 1 hour of sample collection.

Laboratory Investigation

The swabs were directly inoculated on blood agar and MacConkey agar. The pairs of inoculated media were incubated aerobically at 37°C for 24 hours and then examined for bacteria growth according to standard protocol (Cheesbrough 2000). Bacteria were isolated by assessing colony characteristics and Gram reaction and by conducting catalase and coagulase tests; hemolysis, sugar fermentation, and other biochemical tests including indole production, citrate utilization and urease activity; triple sugar iron (TSI) agar test (for glucose, sucrose and lactose fermentation); gas and hydrogen sulphide production tests; and oxidase tests, according to protocols described previously (Cheesbrough 2000). Three or more colony forming units (CFU) were considered before assigning species as a contaminant.

Bacteria isolates were subjected to antibiotic sensitivity analysis using disc diffusion methods (Cheesbrough 2000; WHO 2003) with a commercially available disc (Optun Laboratories Nig Ltd., Lagos Nigeria). Discs for gram-positive organisms contained the following antibiotics: ciprofloxacin, norfloxacin, gentamyicin, lincomycin, streptomycin, rifampin, flucloxasillin, erythromycin, chloramphenicol and ampicillin plus cloxacillin. Discs for Gram-negative organisms contained

the following antibiotics: ofloxacin, perfloxacin, ciprofloxacin, amoxicillan plus clavalanic acid, gentamicin, streptomycin, cephalexin, ampicillin, trimethoprim and nalidixic acid. These antibiotics are commonly used in Nigeria and are available at drug stores in the study area.

Statistical analysis

Differences between proportions were assessed by chi-square analysis. Statistical significance was set at 0.05.

Results

A total of 201 medical students participated in this study, and 201 stethoscopes from these students were examined, 61 from 400-level students, 88 from 500-level students and the remaining 52 from 600-level students. Of these stethoscopes, 161 (80.1%) had bacterial contamination. The various bacteria isolated and the rates of contamination are presented in Table 1. There was no case of mixed infection. The stethoscopes from the 600-level students were the most contaminated, but the difference was not statistically significant ($\chi^2 = 5.25$, df = 2, $p > .05$) (Table 2). Participants' demographic information was related to stethoscope contamination (Table 3), and the result showed a higher proportion of contamination among the stethoscopes from males, individuals above 40 years old and students who were married. However, differences observed with respect to sex ($\chi^2 = 1.74$, df = 1, $p > .05$), age ($\chi^2 = 0.20$, df = 2, $p > .05$) and marital status ($\chi^2 = 0.06$, d f= 1, $p > .05$) (Table 3) were not significant.

Table 1. Bacteria isolates from stethoscopes of medical students

Bacteria isolates	No. (%) isolates	95% confidence interval
Staphylococcus aureus	67 (41.6)	32.8, 50.4
Pseudomonas aeruginosa	49 (30.4)	24.2, 36.6
Escherichia coli	19 (11.8)	5.6, 18.0
Enterococcus faecalis	26 (16.1)	9.9, 22.3
Total	161(80.1)	74.6, 85.6

Stethoscope usage, handling and maintenance (cleaning) practices were related to bacterial contamination (colonization) (Table 4). When colonization was related to the last time the stethoscope was cleaned prior to the survey, the most bacterial colonization was found on stethoscopes that had never been cleaned (93.9%), while the least was found on stethoscopes cleaned 1 week or less (29.2%) before the survey. Statistical analysis showed a significant difference in the trend ($\chi^2 = 51.9$, df = 4, $p < .05$). When the cleaning agent was related to stethoscope colonization by bacteria, results showed the highest colonization among stethoscopes cleaned with only water (78.6%) and those never cleaned with an agent or never cleaned at all (89.9%); the lowest colonization was found among stethoscopes cleaned with methylated spirit (52.5%) and soapy water (50.0%) (Table 4). Again, statistical analysis showed a significant difference in the trend ($\chi^2 = 31.9$, df = 3, $p < .05$).

Table 2. Relationship between students' level and bacterial contamination of stethoscopes

Students' level	No. of stethoscopes examined	No. (%) of stethoscopes contaminated	95% confidence interval
400 level	61	51 (83.6)	74.8, 92.4
500 level	88	74 (84.1)	75.3, 92.9
600 level	52	36 (69.2)	56.8, 81.6
Total	201	161 (80.1)	74.6, 85.6

Table 3. Relationship between students' demographic parameters and bacterial contamination of stethoscopes

Parameters assessed	No. of stethoscopes examined	No. (%) of stethoscopes contaminated	95% confidence interval
Sex			
Male	114	95 (83.3)	76.5, 90.1
Female	87	66 (75.9)	66.9, 84.9
Total	201	161 (80.1)	74.6, 85.6
Age			
≤30	167	133 (79.6)	73.4, 85.8
31–40	27	22 (81.5)	66.3, 96.7
>40	7	6 (85.7)	59.7, 111.6
Total	201	161 (80.1)	74.6, 85.6
Marital status			
Single	159	127 (79.9)	73.7, 86.1
Married	42	34 (81.0)	69.1, 92.9
Total	201	161 (80.1)	74.6, 85.6

Table 4. Relationship between stethoscope cleaning and handling practices and bacteria contamination of stethoscopes

Parameters assessed	No. of stethoscopes examined	No. (%) of stethoscopes contaminated	95% confidence interval
Last time stethoscope was cleaned			
≤1 week ago	24	7 (29.2)	11.0, 47.4
2–4 weeks ago	41	31 (75.6)	62.5, 88.7
5–8 weeks ago	16	14 (87.5)	71.3, 103.7
≥8 weeks ago	21	16 (76.2)	58.0, 94.4
Never cleaned	99	93 (93.3)	89.1, 98.7
Total	201	161 (80.1)	74.6, 85.6
Agent used to clean stethoscope			
Soapy water	8	4 (50.0)	15.5, 84.5
Methylated spirit	40	21 (52.5)	37.5, 67.9
Water only	14	11 (78.6)	57.1, 100.1
No agent/never cleaned	139	125 (89.9)	84.7, 95.1
Total	201	161 (80.1)	74.6, 85.6
Frequency of stethoscope cleaning			
Once daily	12	4 (33.3)	6.3, 60.3
Once weekly	25	12 (54.5)	35.0, 70.0
Once monthly	22	17 (77.3)	59.8, 94.8
Once yearly	10	9 (90.0)	71.4, 108.6
>Once yearly/ never	132	119 (90.2)	85.0, 95.4
Total	201	161 (80.1)	74.6, 85.6
Stethoscope cleaning after each patient			
Yes	18	6 (33.3)	11.8, 54.8
No	183	155 (84.7)	79.5, 89.9
Total	201	161 (80.1)	74.6, 85.6
Handwashing after each patient			
Yes	21	7 (33.3)	12.7, 53.9
No	180	154 (85.6)	80.4, 90.8
Total	201	161 (80.1)	74.6, 85.6

Stethoscope colonization by bacteria was lowest on stethoscopes cleaned once daily (33.3%), compared with those cleaned once yearly (90.0%); the difference was statistically significant ($\chi^2 = 41.8$, df = 4, $p < .05$). A total of 18 students reported cleaning their stethoscope after each patient. Results showed that 33.3% of their stethoscopes were colonized, while 84.7% of stethoscopes from individuals who did not practise this cleaning habit were colonized (Table 4); the difference was statistically significant ($\chi^2 = 26.9$, df = 1, $p < .05$). Students who practise handwashing after each patient had statistically significant lower bacterial contamination on their stethoscopes compared with those who did not wash their hands (33.3% vs. 85.6%; $\chi^2 = 31.9$, df = 1, $p < .05$).

The antibiotic sensitivity test indicated that the bacterial isolates were resistant to most of the antibiotics assessed (Table 5). Isolates of *Staphylococcus aureus* showed the highest susceptibility (susceptible to ciprofloxacin, streptomycin, erythromycin, ofloxacin, amoxicillin plus clavalanic acid). The most effective antibiotics were ciprofloxacin and erythromycin.

Discussion

The high rate of stethoscope contamination (80.1%) observed in this study indicates that the stethoscopes used by the students could be vectors playing a major role in transmitting microorganisms in the hospital environment. This was not surprising since nearly 50% of the students had never cleaned their stethoscope, largely due to the lack of emphasis on stethoscope cleanliness in their training. Earlier studies have also indicated that insufficient emphasis on consistent stethoscope disinfection practices in the medical curriculum are responsible for the high rate of bacterial contamination on stethoscopes of medical students, physicians and other health workers (Zuliani-Maluf et al. 2002; Osorio et al. 2000). A number of studies have demonstrated that 71% to 100% of stethoscopes analyzed were colonized by various species of bacterial agent (Cohen et al. 1997; Zuliani-Maluf et al. 2002; Bernard et al. 1999; Jones et al. 1995; Marinella et al. 1997; Saxena et al. 2005; Smith et al. 1996; Wright et al. 1995).

The spectrum of organisms isolated in this study was also isolated in a number of previous studies (Zuliani-Maluf et al. 2002; Sanders 2003; Madar et al. 2005). Of the bacteria isolated from stethoscopes in this study, *Staphylococcus aureus* was the most common. Previous investigations have found it on 15.8 to 89% of stethoscopes surveyed (Marinella et al. 1997; Saxena et al. 2005; Genné et al. 1996; Sengupta et al. 2000; Sood et al. 2000). An earlier report showed that *Staphylococcus* has developed resistance to conventional antibiotics (WHO 2000), and the findings of our study confirm this. The antibiotic sensitivity test conducted in our study indicated that all the isolated bacteria showed high level of resistance to most of the antibiotics assessed. This is worrisome and a serious public health concern

Table 5. Antimicrobial susceptibility test of bacterial isolates from stethoscopes

Antibiotics	Abbreviation	Concentration	Bacteria isolates			
			S. aureus	*P. aeruginosa*	*E. faecalis*	*E. coli*
Ciprofloxacin	CPX	10 mcg	66.7	33.3	33.3	33.3
Norfloxacin	NB	30 mcg	R	R	R	R
Gentamycin	CN	10 mcg	R	R	R	R
Lincomycin	LC	30 mcg	R	R	R	R
Streptomycin	S	30 mcg	33.3	R	R	R
Rifampin	RD	10 mcg	R	R	R	R
Flucloxasillin	Flx	30 mcg	R	R	R	R
Erythromycin	E	30 mcg	33.3	R	33.3	33.3
Chloramphenicol	CH	20 mcg	R	R	R	R
Ampicillin plus cloxacillin	Apx	30 mcg	R	R	R	R
Ofloxacin	Ofx	10 mcg	33.3	R	R	R
Pefloxacin	PEF	10 mcg	R	R	R	R
Amoxicillin plus clavulanic acid	Au	30 mcg	33.3	33.3	R	R
Cephalexin	CEP	10 mcg	33.3	R	R	R
Nalidixic acid	NA	30 mcg	R	R	R	R
Trimethoprim	SXT	30 mcg	R	R	R	R
Ampicillin	PN	30 mcg	R	R	R	R

R = resistant.

in developing countries, including Nigeria, where dysfunctional health services, inadequate drug supplies, non-adherence to treatment strategies, self-medication and dubious drug quality all favour the emergence and sustenance of microbial resistance (WHO 2000; Uneke and Ogbu 2007). It is well proven that these antibiotic-resistant microorganisms are capable of initiating severe nosocomiasis in a hospital environment and could require contact isolation and aggressive treatment to prevent their spread (Gupta et al. 2004; Gastmeier et al 2003; Kerr et al. 2002; Lange et al. 2000).

Our finding reinforces the dire need to revisit the medical curriculum with the view to integrating adequate stethoscope care as a strategy of controlling nosocomial infections. This is imperative, as a number of studies have shown that when medical students graduate to health workers, only 0–3% of them clean their stethoscopes regularly (Marinella et al. 1997; Saxena et al. 2005; Sengupta et al. 2000; Breathnach et al. 1992). In one study, 10% of healthcare workers cleaned the stethoscope only when blood or human secretions soiled it, and only two out of 100 cleaned it at intervals of 1 to 2 months (Parmar et al. 2004).

In most healthcare settings the prevention of nosocomial infections is given serious consideration. Unfortunately however, primary attention to preventing nosocomial infections is usually paid through high-risk invasive diagnostic tools and therapeutic healthcare procedures. The importance of simple procedures such as hand hygiene and less critical healthcare tools including stethoscopes tends to be underestimated (Sengupta et al. 2000; Madar et al. 2005). By the virtue of their constant contact with patients by touch and by their stethoscopes, healthcare workers and medical students become potential sources of hospital-acquired pathogenic agents. All need to wash their hands before and after seeing each patient. Failure to do so could facilitate the introduction of pathogens on any device that the health worker uses frequently, such as the stethoscope.

Our study demonstrates the importance of hand hygiene. The rate of bacterial contamination was lower on stethoscopes of medical students who practised handwashing after each patient, and the difference was significant ($p < .05$). This was not unexpected since most hospital-acquired pathogens are transmitted from patient to patient via the hands of healthcare workers (Larson 1988). Handwashing has been shown as the simplest and most effective, proven method to reduce the incidence of nosocomial infections (Pittet 2000). However, despite being one of the most basic, as well as the most vital infection control measure, it is one of the most neglected practices (Bryan 1986; Pittet et al. 1999; Harris et al. 2000). Identifying effective methods to improve the practice of handwashing would greatly enhance patient safety and result in a significant decrease in hospital-acquired infections.

Stethoscopes from students who cleaned them after seeing each patient had significantly lower rate of bacteria contamination ($p < .05$). Previous studies have shown that this practice substantially reduces the potential of bacteria transmission by stethoscopes (Marinella et al. 1997; Saxena et al. 2005; Sood et al. 2000). Our study demonstrates the importance of cleaning the stethoscope with a disinfectant. There was comparatively less bacterial colonization on stethoscopes of students who used soapy water and methylated spirit as cleaning agents. An earlier study showed that bacterial colony counts were significantly reduced from the stethoscope diaphragm after cleaning with isopropyl alcohol, sodium hypochlorite or benzalkonium chloride (Marinella et al. 1997). Another related report indicated that cleaning the stethoscope diaphragm resulted in immediate reduction in the bacterial count: by 94% with alcohol swabs, 90% with nonionic detergent and 75% with antiseptic soap (Jones et al. 1995). Cleaning with soap and water would be the simplest and most convenient method of disinfecting the stethoscope (Africa-Purino et al. 2000).

Conclusion

In conclusion, this study makes a case for including stethoscope care in the training curriculum of medical schools. Furthermore, it has been suggested that hospitals need to develop more rigorous programs and protocols for stethoscope disinfection as a standard of care (Bernard et al. 1999). Implementing policies that would facilitate strict adherence to stethoscope disinfection practices by health workers and medical students on their clinical postings will minimize the rate of nosocomial infections and improve the safety of patients, healthcare workers and any other person in the hospital environment. HQ

References

Africa-Purino, F.M.C., E.E.R. Dy and R.F. Coronel. 2000. "Stethoscopes: A Potential Source of Nosocomial Infections." *Philippines Journal Microbiology & Infectious Diseases* 29(2): 9–13.

Bernard, L., A. Kereveur, D. Durand, F. Goldstein, J.L. Mainardi, J. Acar and J. Carlet J. 1999. "Bacterial Contamination of Hospital Physician's Stethoscopes." *Infection Control & Hospital Epidemiology* 20: 626–8.

Breathnach, A.S., D.R. Jenkins and S.J. Redler. 1992. "Stethoscope As Possible Vectors of Infection by Staphylococci." *British Medical Journal* 305: 1573–4.

Bryan, C.S. 1986. "Of Soap and Semmelweis." *Infection Control* 7: 445–7.

Cheesbrough, M. 2000. *District Laboratory Practice in Tropical Countries*; Part 2 (pp. 34–243). UK: Cambridge University Press.

Cohen, H.A., J. Amir, A. Matalon, R. Mayan, S. Beni and A. Barzilai. 1997. "Stethoscopes and Otoscopes – A Potential Vector of Infection?" *Family Practice* 14(6): 446–9.

Gastmeier, P., K. Groneberg, K. Weist and H. Rüden. 2003. "A Cluster of Nosocomial Klebsiella pneumoniae Bloodstream Infections in a Neonatal Intensive Care Department: Identification of Transmission and Intervention." *American Journal of Infection Control* 31(7): 424–30.

Genné, D., A. de Torrenté, L. Humair and H.H. Siegrist. 1996. "Level of Stethoscope Contamination in the Hospital Environment." *Schweizerische Medizinische Wochenschrift* 126(51–52): 2237–40.

Gupta, A., P. Della-Latta, B. Todd, J. San Gabriel, F. Haas, D. Wu, D. Rubenstein and L. Saiman. 2004. "Outbreak of Extended-Spectrum Beta-Lactamase-Producing Klebsiella Pneumoniae in a Neonatal Intensive Care Unit Linked to Artificial Nails." *Infection Control & Hospital Epidemiology* 25(3): 210–5.

Haley, R.W., D.H. Culver, J.W. White, W.M. Morgan, T.G. Emori and V.P. Munn. 1985. "The Efficacy of Infection Surveillance and Control Programs in Preventing Nosocomial Infection in US Hospitals." *American Journal of Epidemiology* 121: 182–205.

Harris, A.D., M.H. Samore, R. Nafziger, K. Dirosario, M.C. Roghmann and Y. Carmeli. 2000. "A Survey on Handwashing Practices and Opinions of Healthcare Workers." *Journal of Hospital Infection* 45: 318–21.

Hoogkamp-Korstanje, J.A., B. Cats, R.C. Senders and I. van Ertbruggen. 1982. "Analysis of Bacterial Infections in a Neonatal Intensive Care Unit." *Journal of Hospital Infection* 3: 275–284.

Jones, J.S., D. Hoerle and R. Riekse. 1995. "Stethoscopes: a Potential Vector of Infection?" *Annals of Emergency Medicine* 26: 296–9.

Kerr, J.R., H. Martin, M.V. Chadwick, A. Edwards, M.E. Hodson and D.M. Geddes. 2002. "Evidence against Transmission of Pseudomonas aeruginosa by Hands and Stethoscopes in a Cystic Fibrosis Unit." *Journal of Hospital Infection* 50(4): 324–6.

Klevens, R., J.R. Edwards, C.L. Richards, T.C. Horan, R.P. Gaynes, D.A. Pollock and D.M. Cardo. 2007. "Estimating Health Care-Associated Infections and Deaths in U.S. Hospitals, 2002." *Public Health Reports* 122: 160–6.

Lange, C.G., A.B. Morrissey and C.J. Donskey. 2000. "Point-Prevalence of Contamination of Healthcare Workers' Stethoscopes with Vancomycin-Resistant Enterococci at Two Teaching Hospitals in Cleveland, Ohio." *Infection Control & Hospital Epidemiology* 21(12): 756.

Larson, E. 1988. "A Causal Link between Handwashing and Risk of Infection? Examination of the Evidence." *Infection Control and Hospital Epidemiology* 9:28–36.

Lazzari, S., B. Allegranzi and E. Concia. 2004. "Making Hospitals Safer: the Need for a Global Strategy for Infection Control in Healthcare Settings." *World Hospitals and Health Services*, 32: 34,36–42.

Madar, R., E. Novakova and Baska, T. 2005. "The Role of Non-critical Health-Care Tools in the Transmission of Nosocomial Infections." *Bratislavske Lekarske Listy* 106(11): 348–50.

Marinella, M.A., C. Pierson and C. Chenoweth. 1997. "The Stethoscope - a Potential Source of Nosocomial Infection?" *Archives of Internal Medicine* 157: 786–90.

Orrett, F.A., P.J. Brooks and E.G. Richardson. 1998. "Nosocomial Infections in a Rural Regional Hospital in a Developing Country: Infection Rates by Site, Service, Cost, and Infection Control Practices." *Infection Control & Hospital Epidemiology* 19(2): 136–40.

Osorio, N.G., C. Oro, B.T. Ong and E.R, Emmanuel Dy. 2000. "The Effect of a Traditional Educational Intervention on the Knowledge, Attitudes and Practices Regarding Stethoscope Use Among UST Senior Infectious Tropical Medicine Students." *Philippines Journal of Microbiology & Infectious Diseases* 29(4): 153–5.

Parmar, R.C., C.C. Valvi, P. Sira and J.R. Kamat. 2004. "A Prospective, Randomised, Double-Blind Study of Comparative Efficacy of

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PatentStorm. US Patent Issued in 2004. "Disposable Cover for Stethoscope Head." Retrieved June 15, 2008. <http://www.freepatentsonline.com/5747751.html>.

Pittet, D. 2005. "Infection Control and Quality Health Care in the New Millennium," *American Journal of Infection Control* 33(5):258–67.

Pittet, D. 2000. "Improving Compliance with Hand Hygiene in Hospitals." *Infection Control and Hospital Epidemiology* 21:381–6.

Pittet, D., P. Mourouga and T.V. Perneger. 1999. "Compliance with Handwashing in a Teaching Hospital." *Annals of Internal Medicine* 130: 126–30.

Sanders, S. 2003. "The Stethoscope and Cross-Infection." *British Journal of General Practice* 53(497): 971–2.

Saxena, A.K., B.R. Panhotra and A.S. Al-Mulhim. 2005. "Contaminated Physician's Stethoscope – A Potential Source of Transmission of Infection in the Hospital. Need of Frequent Disinfection after Use." *Saudi Medical Journal* 26(2): 348–50.

Sengupta, S., A. Sirkar and P.G. Shivananda. 2000. "Stethoscopes and Nosocomial Infection." *Indian Journal of Pediatrics* 67(3): 197–9.

Smith, M.A., J.J. Mathewson, A. Ulert, E.G. Scerpella and C.D. Ericsson. 1996. "Contaminated Stethoscopes Revisited." *Archives of Internal Medicine* 156: 82–4.

Sood, P., B. Mishra and A. Mandal. 2000. "Potential Infection Hazards of Stethoscopes." *Journal of Indian Medical Association* 98(7): 368–70.

Tikhomirov, E. 1987. "WHO Programme for the Control of Hospital Infections." *Chemiotherapia* 3:148–51.

Uneke, C.J. and O. Ogbu. 2007. "Potential for Parasite and Bacteria Transmission by Paper Currency in Nigeria." *Journal of Environmental Health* 69(9): 54–60.

Vincent, J.L. 2003. "Nosocomial Infections in Adult Intensive Care Units." *Lancet* 361: 2068–77.

World Health Organization. 10 *Facts on Patient Safety*. Retrieved September 17, 2008. <http://www.who.int/features/factfiles/patient_safety/en/index.html>.

World Health Organization. 2000. Overcoming Antimicrobial Resistance. Retrieved September 2, 2008. <www.who.int/infectious-disease-report/2000/>.

World Health Organization. 2003. *Manual for the Laboratory Identification and Antimicrobial Sensitivity Testing of Bacterial Pathogens of Public Health Importance in Developing World* (pp 103–20). WHO/DCS/CSR/RMD/2003.6. Geneva: Author.

Wright, I.M., H. Orr and C. Porter. 1995. "Stethoscope Contamination in the Neonatal Intensive Care Unit." *Journal of Hospital Infection* 29(1): 65–8.

Zuliani-Maluf, M.E., A.F. Maldonado, M.E. Bercial and S.A, Pedroso. 2002. "Stethoscope: a Friend or an Enemy?" *Sao Paulo Medical Journal* 120(1): 13–5.

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